



FAA-E-2549
January 10, 1973

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SPECIFICATION

RECORDER/REPRODUCER, MAGNETIC TAPE, INSTRUMENTATION TYPE

1. SCOPE

1.1 Scope. - The equipment covered by this specification is a magnetic tape instrumentation recorder/reproducer suitable for the recording and playback of real time digital and analog data.

2. APPLICABLE DOCUMENTS

2.1 Publications.- The following publication, of the issue in effect on the date of the invitation to bids or request for proposals, forms a part of this specification and is applicable to the extent specified herein.

IRIG Document 106-71	Telemetry Standards
IRIG Document 118-71	Test Procedure
FAA-STD-013	Quality Control Program
FAA-G-2100/1	Electronic Equipment General Requirements
FAA-STD-001	Color and Texture of Finishes for National Airspace System

2.2 Precedence of documents.- When requirements of the contract, this specification, or subsidiary documents are in conflict, the following precedence shall apply:

2.2.1 The Contract.- The contract shall have precedence over all other documents.

2.2.2 Specification.- This specification shall have precedence over all subsidiary documents referenced herein.

2.2.3 Applicable documents.- Any subsidiary applicable documents referenced herein shall have precedence over all subsidiary documents referenced therein.

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each recorder/reproducer furnished by the contractor shall be complete in accordance with all specification requirements and shall include the items tabulated below. Any feature or item necessary for proper operation in accordance with the requirements of this specification, shall be incorporated even though that feature or item may not be specifically described herein. Quantities of each item, and delivery locations and times shall be as specified in the contract.

- (a) Instrumentation Tape Transport including control and drive circuitry (3.4.2).
- (b) Pulse Code Modulation (PCM) Record/Reproduce Amplifiers (3.4.3.3).
- (c) Direct Recording Record/Reproduce Amplifiers (3.4.3.4).
- (d) Time Display and Transfer Electronics (3.5).
- (e) Instruction Books (3.9.1).
- (f) Test Specifications (3.9.2).
- (g) Installation Instructions (3.9.3).
- (h) Optional features (3.4.2.16).
- (i) Special Tools and Test Equipment (3.1.2).

3.1.1 Cables and connectors.- The contractor shall furnish all inter and intraconnecting cables and connectors. Mating connectors for signal input, signal output and remote control functions shall be provided by the contractor. Power cables and connectors shall be provided by the contractor. BNC connectors shall be provided for signal input and output connections.

3.1.2 Special tools and test equipment.- All special test equipment and tools necessary for the installation, repair, adjustment, test and maintenance of the recorder/reproducer specified herein, not readily available on the open market, such as, alignment wrenches, testing devices, jigs, special purpose test cables, circuit card extenders, etc., shall be supplied as part of the equipment. The design of the equipment shall be such as to permit the use of standard tools and test equipment, insofar as practicable.

3.2 Definitions

3.2.1 Dynamic skew.- Dynamic skew is the relative time displacement of an event recorded simultaneously on any two adjacent tracks within the same head stack as observed on playback.

3.2.2 Flutter.- Flutter is the instantaneous "short term" speed deviation from the "long term" average speed of the recorder/reproducer. For the purpose of this specification, the lower frequency limit of flutter measurements will be 0.2 Hz.

3.2.3 IRIG.- Inter-Range Instrumentation Group. An advisory organization whose purpose is to provide standards for data collection in missile and aircraft tracking ranges.

3.2.4 Time Base Error.- If the time interval between any two events recorded on tape is compared with the reproduced time interval of the same two events during playback, the difference between the recorded interval and the reproduced interval is time base error. The points of measurement may be anywhere within the reel and include the worst case of one point at the beginning of the reel and one at the end. In making these measurements, a tape servo system operating from a reference track recorded on the tape is assumed, otherwise the measurements are indeterminate.

3.3 General Functional Requirements.- Each recorder/reproducer shall consist of a tape transport and associated control and signal electronics to provide a 32-channel recording/reproducing capability. Two types of plug-in, interchangeable signal electronics modules shall be provided; Pulse Code Modulation (PCM), and Intermediate Band Direct. The quantities of each type shall be as specified in the contract.

3.4 Detailed Requirements

3.4.1 Tape.- The requirements of this specification shall be met by the use of the following type of magnetic tape, or equivalent:

- (a) Minnesota Mining and Manufacturing Co. (3M) Type 888-1-9200-IR.
- (b) Ampex Type 772, 1 mil.

3.4.2 Tape transport.- The tape transport shall meet the following requirements.

3.4.2.1 Tape size.- The tape transport shall be capable of operating with 1.0 mil thickness polyester-backed tapes of 1 inch nominal width.

3.4.2.2 Reels and Reel Hubs.- The tape transport shall accept reels conforming to Electronic Industries Association (EIA) standards without modification or readjustment. The transport shall be capable of operating with reels of either 10-1/2 or 14 inch diameter, and shall wind and rewind the tape evenly on the reels. Reel hubs shall be coplanar with a non-detachable positive locking mechanism having no removable parts.

3.4.2.3 Drive mechanism.- A single low mass capstan shall be used to move the tape in the record/reproduce modes of operation. Tape tension shall be controlled by reel drive servo(s), and shall be independent of the capstan drive system.

3.4.2.4 Braking.- The transport shall be equipped with fail-safe emergency braking, which is automatically actuated in the event of power failure or tape breakage. Batteries or other emergency power supplies shall not be required. In addition, tape breakage shall activate a visible and audible alarm. A switch shall be provided which, when selected, will disable the function of the audible alarm.

3.4.2.5 Tape speeds.- As a minimum, transport tape speeds provided shall be 30, 15, 7-1/2 and 3-3/4 ips. Tape speed accuracy in the record or reproduce modes, when not using a tape servo speed control system, shall be within $\pm 0.20\%$ of the selected speed. Tape speeds and forward/reverse drive direction shall be electrically selectable. Mechanical changes shall not be used to achieve speed changes. Additionally, a non-locking switch shall be provided on the front of the recorder/reproducer which, when activated, will either advance or retard momentarily the speed of the tape. This feature will allow manual intervention when necessary to adjust for minimal differences in tape position and start up times between two recorders.

3.4.2.6 Fast wind time.- Fast forward or fast reverse for 14 inch reel with 5000 feet of tape shall be less than 7 minutes. The tape shall be continuously under capstan control. Tape speed shall not exceed 2000 feet per minute.

3.4.2.7 Time base error.- The time base error shall not exceed the following tolerances for the given speeds, when measured as specified in IRIG 118-71:

<u>Tape Speed</u> <u>Inches Per Second</u>	<u>Error in</u> <u>Microseconds</u>
30	± 1.00
15	± 2.00
7-1/2	± 4.00
3-3/4	± 8.00

3.4.2.8 Dynamic skew.- The relative time displacement of an event recorded simultaneously on any two adjacent tracks within the same head stack as observed on play back shall be less than:

<u>Tape Speed</u> <u>Inches Per Second</u>	<u>ΔT Microseconds</u> <u>Zero to Peak</u>
30	0.6
15	1.2
7-1/2	2.4
3-3/4	4.8

3.4.2.9 Flutter.- The cumulative flutter, peak-to-peak shall not exceed the following percentages:

<u>Tape Speed (ips)</u>	<u>Flutter Bandwidth</u>	<u>% Flutter</u> <u>(Peak-to-Peak)</u>
30	0.2 Hz to 5 kHz	0.40
15	0.2 Hz to 2.5 kHz	0.50
7-1/2	0.2 Hz to 1.25 kHz	0.60
3-3/4	0.2 Hz to 625 Hz	0.70

3.4.2.10 Start and stop times.- The start time to meet flutter specification shall not exceed 8.0 seconds at any selectable speed. The stop time shall not exceed 4.0 seconds at any selectable speed.

3.4.2.11 Tape synchronous servo. - A tape synchronous servo speed control to ensure that the reproduce tape speed closely duplicates the record tape speed shall be provided. The speed control shall function within the following specifications at all tape speeds.

3.4.2.11.1 Servo reference frequency.- The servo reference frequency recorded shall be 50 kHz \pm 0.01% at 30 inches per second and proportionately lower at the lower tape speeds (per IRIG 106-71), as indicated in the following table. The capability shall be provided to record this frequency on a single track when the appropriate electronics are provided.

<u>Speed (ips)</u>	<u>Reference Frequency</u>
30	50 kHz
15	25 kHz
7-1/2	12.5 kHz
3-3/4	6.25 kHz

3.4.2.11.2 Reference oscillator stability.- Shall be less than 2 parts in a million (10^6).

3.4.2.11.3 Servo light indicators.- Shall be provided on the front control panel to indicate capstan drive synchronization and to verify reproduction of a tape reference signal.

3.4.2.12 Heads.- Record/reproduce heads for 1 inch tape shall be provided. The head assembly shall be of the modular plug-in variety and shall be capable of being field installed without the need for special tools, gauges, shimming or adjustment.

3.4.2.12.1 Head life.- Head life shall be a minimum of 1500 hours when recording or reproducing at 30 inches per second.

3.4.2.12.2 Head spacing.- Head stacks shall be spaced 1.5000 \pm 0.002 inches, gap-to-gap, along the tape path.

3.4.2.13 Track registration.- The recorded track as measured from a single reference edge of the tape shall be within \pm 0.003 inches of the nominal track center line.

3.4.2.14 Time totalizing meters.- The equipment shall contain digital time totalizing meters which shall record total "power on" time and head running time.

3.4.2.15 Transport controls

3.4.2.15.1 Local controls.- As a minimum, local controls shall be provided for controlling the following functions:

- (a) Main power
- (b) Speed selection
- (c) Forward

- (d) Reverse
- (e) Fast Forward
- (f) Fast Reverse
- (g) Stop
- (h) Record
- (i) Remote

3.4.2.15.2 Remote control.- Remote control provision shall be available as a minimum for the following functions. Connection for these functions shall be provided at the rear of the tape transport. A remote control panel shall be available as an optional item (3.4.2.16.4). The panel shall also include alarm indicator for tape breakage and power failure.

- (a) Forward
- (b) Reverse
- (c) Fast Forward
- (d) Fast Reverse
- (e) Stop
- (f) Record

3.4.2.16 Optional features.- The following features shall be provided as tape transport options.

3.4.2.16.1 Search and shuttle.- A means shall be provided for searching the tape to a selectable preset location. In addition, a means of shuttling between two such selectable preset points, to permit repetitive playback of selected portions of a tape, shall be available. The method may be a simple electromechanical technique, such as footage counters, since a high degree of accuracy is not required.

3.4.2.16.2 Tape sensing.- A means shall be provided for sensing end of tape and end of reel. The tape transport control circuitry shall be interlocked with the sense circuits to stop the tape drive mechanism if either of these conditions are sensed. In addition, a visible and audible alarm shall be activated.

3.4.2.16.3 Footage counter.- An indicating device reading in feet of tape passing the record/reproduce heads shall be provided. It shall be at least 5-digit and resettable.

3.4.2.16.4 Remote control panel.- A remote control panel including 200 feet

of cable, with connectors, shall be provided if specified in the contract. The panel shall include the necessary switches and indicators to control the functions listed in 3.4.2.15.2.

3.4.2.16.5 Signal monitoring.- A "quick look" type of signal monitor shall be provided. This monitor shall provide simultaneous monitoring of all 32 channels to ensure that data is being recorded on all selected tracks and also to monitor the output during playback. Since the indication required is only the presence or absence of data, a simple indicator, such as a neon lamp for each channel, will suffice. This monitoring capability shall not interfere with the use of the input/output jacks provided in the amplifier bays.

"3.4.2.16.6 Sequential Operation.- A means shall be provided for automatic sequential operation of two recorder/reproducers. Each unit shall, upon detection of end-of-tape or end-of-reel, signal the companion recorder/reproducer to start recording and rewind itself to the beginning-of-tape record position."

"3.4.2.16.7 Tape Re-record.- A means shall be provided to record on a tape repeatedly without removal of that tape from the recorder/reproducer such that the record/reproduce characteristics of this specification are met. This feature will permit sequential operation of two recorder/reproducers without removal of the tape from the unit and may be accomplished by use of an erase head. Additionally, the capability of disabling this function shall be provided with an appropriate indicator visible on the front of the recorder. This indicator will alert an operator that this function is disabled."

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3.4.3 Signal electronics.- Two types of signal electronics modules shall be provided: Pulse Code Modulation (PCM), and Intermediate Band Direct. Quantities of each type shall be as specified in the contract. All speed dependent electronics shall be automatically switched when tape speed is changed. These electronics shall provide, as a minimum, the capability of reproducing a tape at the recorded speed as well as two and four times the recorded speed within the tape speeds specified in paragraph 3.4.2.5.

3.4.3.1 Packaging.- The construction of the signal electronics amplifiers shall be modular in nature. Amplifiers for the two methods (PCM, Direct) of recording/reproducing shall be directly interchangeable so that any track combination of recording/reproducing may be obtained by plugging in the appropriate amplifiers.

3.4.3.2 Front accessibility.- All normal operator controls, e.g., levels, shall be available from the front of the cabinet without withdrawing amplifier bays. All controls shall be clearly identified as to function.

3.4.3.3 Pulse Code Modulation.- The Pulse Code Modulation (PCM) modules will be used for recording and reproducing real time digital data and shall have the following characteristics. Serial PCM shall be provided.

3.4.3.3.1 Pulse Code Modulation (PCM) transfer and error rate.- At 2000 bits per inch per track, errors shall be less than 1 bit in 10^6 bits per track.

3.4.3.3.2 Record and reproduce speed selection.- The PCM system shall operate at 30, 15, 7-1/2 and 3-3/4 inches per second.

3.4.3.3.3 PCM input and output logic levels.- The PCM write amplifiers shall accept input logic signals as follows:

Logical 0 = 0 to -8 volts

Logical 1 = +3 to +8 volts

PCM read amplifier output signal levels shall be:

Logical 0 = -6 volts \pm 1 volt

Logical 1 = +6 volts \pm 1 volt

3.4.3.3.4 Input rise time.- The PCM input shall accept signals having rise times of 20 microseconds or less.

3.4.3.3.5 Input impedance.- Input impedance shall be not less than 1000 ohms, unbalanced to ground with a shunt capacitance not to exceed 150 picofarads.

3.4.3.3.6 Output rise time.- The output rise time shall be 1.5 microseconds or less measured from 10% to 90% points.

3.4.3.3.7 Output impedance.- The output amplifier shall be capable of driving any load impedance between 50 ohms and 150 ohms resistive.

3.4.3.4 Intermediate band direct recording.- The direct recording modules will be capable of recording and reproducing real time analog signals from 200 Hz to not less than 100 kHz.

3.4.3.4.1 Tape speed and frequency response.- The frequency response at minimum S/N ratio for various tape speeds shall be as defined in the following table:

<u>Inches Per Second</u>	<u>Minimum Bandwidth</u>	<u>S/N (RMS Signal to RMS Noise)*</u>
30	200 Hz to 100 kHz \pm 3 db	29 db
15	200 Hz to 50 kHz \pm 3 db	28 db
7-1/2	200 Hz to 25 kHz \pm 3 db	26 db
3-3/4	200 Hz to 12.5 kHz \pm 3 db	26 db

*Measured at the output of a bandpass filter having 18 db per/octave attenuation beyond limits stated. These figures include the effects of crosstalk from an adjacent, normally recorded, track in the same head stack, and may be 3 db lower at the frequencies between 200 Hz and 1 kHz for each tape speed.

3.4.3.4.2 Harmonic distortion.- With a 1 kHz sinusoidal signal (recorded at normal level), third harmonic content shall be less than 1% as per IRIG 106-71.

3.4.3.4.3 Input level.- The direct recording system shall accept input signals over a minimum range from 0.25 volts to 10 volts rms, unbalanced to ground.

3.4.3.4.4 Output level.- The output level shall be not less than 1 volt rms across 75 ohms.

3.4.3.4.5 Output impedance.- The output amplifier shall drive any load impedance between 50 ohms and 150 ohms resistive.

3.4.3.4.6 Input impedance.- The input impedance of the direct recording amplifiers shall be not less than 10,000 ohms unbalanced to ground. Shunt capacitance shall not exceed 150 picofarads.

3.5 Time display and transfer electronics.- A means shall be provided to display the recorded time-of-day and transfer this data to an external IBM 360 computer. The display and electronics shall be located within the recorder.

3.5.1 Time display.- A display shall be provided for readout of the reproduced time-of-day data as recorded on one of the direct record/reproduce tracks. The format of the time code is a modified IRIG-E serial code using a 600 Hz carrier frequency and is shown in Appendix A of this specification. The time display shall be in hours, minutes and seconds and may be provided by the use of Nixie tubes, seven segment readout or any similar method. A separate 20 line buffered parallel BCD output of the hours, minutes and seconds shall be provided at the rear of the display assembly on a multi-pin connector.

3.5.2 Time transfer Electronics (TTE).- Logic circuitry shall be provided as part of the time display which will transfer the parallel BCD time code (from the time display) into a bit-parallel, byte serial format upon request from a General Purpose Input (GPI) adapter of an IBM 360 computer. The circuitry will provide time-of-day information corresponding to the recorded digital data for input to the computer. Details, including data formats and adapter timing charts, are included as Appendix B of this specification. A logic drawing of suggested circuitry to accomplish this time transfer can be provided by the Government upon request.

3.6 Service conditions.- The equipment shall meet the service conditions specified herein.

3.6.1 Environmental.- The equipment shall meet the performance requirements specified herein under any combination of the operating environments specified in the following table, and after exposure to the non-operational environments specified in this table. Adjustment of the operating controls only shall be permitted after stabilization with the operating environment.

	Non-operating	Operating
Temperature	-20°C to +60°C	+5°C to 50°C
Altitude	to 50,000 feet	to 10,000 feet
Relative Humidity	10 to 95% Non-Condensing	10 to 95% Non-Condensing

3.6.2 Electrical power.- The equipment shall meet the performance requirements specified herein when operated over the following ranges of voltage and frequency:

Voltage: 105 to 125 volts AC

Frequency: 57 to 63 Hz single phase

Power consumption: Not to exceed 2000 volt amperes for a
32 track recorder/reproducer

3.7 Construction

3.7.1 General.- The equipment shall be constructed to meet the service conditions specified in Paragraph 3.6. Modular packaging techniques shall be used.

3.7.2 Cabinet Assembly.- The equipment shall be contained in a single upright metal cabinet not to exceed 78 inches in height. Width or depth shall not exceed 28 inches. The equipment cabinet assembly shall be designed so that it will not be necessary to bolt or fasten down the cabinet; however, facilities to bolt or fasten down cabinets shall be provided.

3.7.3 Service life.- The equipment shall be designed to have a minimum total operational life of 5 years, with the prescribed maintenance and replacement of parts. Parts requiring preventive maintenance or periodic replacement shall be specified by the contractor on a list submitted to the Government thirty (30) days prior to the delivery of the first equipment. The list shall specify the recommended maintenance or replacement intervals.

3.7.4 Equipment stability.- The equipment shall meet the performance specifications contained herein over any continuous 8 hour period* without adjustment of any controls other than normal operator controls.

* Exclusive of tape changes

3.7.5 Accessibility.- All controls, test points, adjustments and modules components for operational setup and alignment of the equipment shall be accessible from the front of the cabinet.

3.7.6 Acoustic interference.- In the record and reproduce modes of operation, the acoustic noise radiated by the equipment shall not exceed the noise level criteria of Condition A, Paragraph 1-3.5.11 of Specification FAA-G-2100/1.

3.8 Reliability.- The recorder/reproducer specified herein shall meet the following reliability requirements.

- (a) The Mean-Time Between Failures (MTBF) shall be not less than 250 hours. (Failure is defined as any malfunction which causes the equipment to fail to meet the minimum performance requirements specified for the equipment.)
- (b) The Mean-Time to Repair (MTTR) shall not exceed 30 minutes.
- (c) The Mean Preventive Maintenance Time (MPMT) shall not exceed 1 hour per 50 hours of operation. (Operation is defined as having the main power switch turned on, whether the tape drive is running or not.)

- (d.) A 48 hour test shall be scheduled as the final test to be completed on the equipment at the contractor's plant. The recorder/reproducer shall be operated continuously for 48 hours to demonstrate stability for continuous operation. After a brief warmup period (no longer than 15 minutes), the equipment shall be aligned for optimum performance and test measurements taken and recorded. Test measurements shall be made four times during the 48 hour test at approximately 12 hour intervals. During the final six hours of the 48 hour test, the equipment shall be alternately de-energized for one-half hour and energized for one hour three times. All observations of malfunctioning or instability shall be recorded on the test data sheets which act as a log or history of the test. All requirements shall be met during the 48 hour test period without readjustment of controls, except as may be otherwise permitted in this specification.

The contractor shall propose his method of demonstrating compliance with this requirement. The proposed method is subject to Government approval (paragraphs 3.9.2 and 4.3.2).

3.9 Documentation.- The contractor shall provide the following documentation as specified herein.

3.9.1 Instruction books.- Operation/maintenance manuals shall be furnished as required by the contract.

3.9.2 Test Specification.- The contractor shall submit five copies of a recommended test specification not later than thirty (30) days from date of contract. The Government will review, approve and direct necessary changes to the Test Specification. The Test Specification shall be written such that the specified tests shall demonstrate compliance with this specification.

3.9.3 Installation instructions.- Installation instructions and drawings shall be provided in accordance with the terms of the contract.

3.9.4 Standard test equipment list.- The contractor shall submit six (6) copies of his recommended standard test equipment and tools listing not later than thirty (30) days from date of contract.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for testing.- All inspections and tests specified herein shall be performed at the contractor's plant (at one location in the continental United States). Unless otherwise specified, all tests shall be performed by the contractor and may be witnessed by an FAA representative. The contractor shall make available for Government inspection each equipment to be delivered under the contract, if so requested by the Government. The Government reserves the right to waive witnessing any portion of the inspection; in lieu thereof, the contractor shall furnish certified test data for each equipment, showing compliance with the specification requirements.

4.2 Test equipment.- The contractor shall furnish all facilities and test equipment necessary for factory testing. Test instruments used shall have rated accuracies which are not less than three times better than the specified tolerances of the quantity being measured.

4.3 Factory tests and inspections.

4.3.1 Quality control.- The contractor shall provide and maintain a quality control system acceptable to the Government in accordance with specification FAA-STD-013a. The equipment shall be examined to verify that it has been fabricated to the best commercial workmanship and standards. It shall be examined to determine completeness, accuracy and dimensions, quality of workmanship, weight, use of proper materials and finishes, and visible defects. All controls and moving parts shall be examined to insure that they operate freely yet with sufficient accuracy to preclude malfunctions.

4.3.2 Performance tests.- The performance requirements of this specification shall be demonstrated by factory tests in accordance with the Government approved test specification (3.9.2). Simulated inputs shall be used, exercising all equipment functions, to demonstrate the ability of the equipment to accept inputs correctly, to provide the required processing, to provide the correct outputs, and to meet all of the other requirements of this specification.

4.3.3 Notification of readiness for inspection.- The contractor shall notify the contracting officer or the FAA inspector, if assigned, in writing of his readiness for inspection at least five (5) working days prior to the inspection date.

4.3.4 Final inspection.- Preliminary inspection and acceptance may be made by a Government representative at the contractor's plant. Final inspection and acceptance shall be made at destination.

5. PREPARATION FOR DELIVERY

5.1 General.- All items comprising each recorder/reproducer system shall be packed, crated, and provided with necessary identification markings (as specified in the contract) in accordance with good commercial practice for domestic shipment by common carrier. Instruction books, any other associated documentation, installation materials, spare parts and related items shall be included with each system shipment unless excluded from, or otherwise specified in, the contract.

6. NOTES

6.1 None.

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APPENDIX A

To Specification FAA-E-2549

The diagram illustrates the timing of a 100 MHz signal. It features a horizontal axis labeled "TIME IN SECONDS" with major ticks every 10 seconds (0, 10, 20, 30, 40, 50). A vertical axis on the left is labeled "PER TIME" and "REF. MARKER". The signal waveform is shown as a series of pulses. Key time intervals and markers are indicated:

- PER TIME**: A vertical line at the start of the signal.
- REF. MARKER**: A vertical line at the start of the signal.
- BASE (77)**: A vertical line at the start of the signal.
- SECONDS**: A bracket indicating the first 10 seconds of the signal.
- MINUTES**: A bracket indicating the next 10 minutes of the signal.
- HOURS**: A bracket indicating the next 10 hours of the signal.
- ERROR AND CONTROL I.D.**: A bracket indicating the next 10 minutes of the signal.
- WIDE SYNC 375P 180V**: A vertical line at the start of the signal.
- WIDE SYNC 200V**: A vertical line at the start of the signal.
- 1.0 SECOND INDEX MARKER**: A vertical line at the 10-second mark.
- 10 SEC. INDEX MARKER**: A vertical line at the 10-minute mark.

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APPENDIX B
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Time Transfer Electronics

The GPI adapter will initiate the request for time-of-day data by raising one of its two Device Control lines to the Time Transfer Electronics (TTE). When control line 1 is raised, the adapter is requesting update time. When device control line 3 is raised, the computer is requesting immediate time. The TTE shall respond to only one control line at a time.

In an immediate time request, the TTE will reply with a single 4 byte data burst (8 bits parallel/byte). The first byte of this burst (hours) shall be placed on the data lines and the TTE I/O Request line shall be raised within 15 μ sec after the start of the next second interval as determined from the time display. When the adapter has sampled the data line, it will raise its Adapter Response line which shall cause the TTE to lower its I/O Request line. Upon sensing the inactive I/O Request line, the GPI adapter then lowers its Adapter Response line. This completes the transfer of the first byte. Interface timing is shown on Figure 2.

A minimum of 5 μ sec shall occur between successive bytes. The TTE shall then place the second byte (minutes) on the data lines and again raise its I/O Request line. The timing sequence of the remaining bytes shall be as in the first byte. The third byte shall be the seconds data and the fourth byte shall be a Plus Zero byte (see Figure 3). The Adapter Response, resulting from the Plus Zero byte, shall cause the TTE to raise its EOM (End of Message) line and terminate the request.

The update time request shall consist of two bursts of four data bytes each. The time interval separating the two bursts shall be selected from a front panel switch and shall be one of the following intervals: 1 sec, 2 sec, 10 sec, 20 sec, 30 sec, or 60 seconds. The first burst is similar to an immediate time burst, except that the first byte and the TTE I/O Request occur within 15 μ sec after the beginning of the next switch-selected update time interval. There shall be no EOM resulting from the Plus Zero byte in the first burst. An example of the update time interval sequence is as follows: The adapter raises its control line for update time at 10:31:26 and the interval switch is set at 10 seconds. The TTE logic waits until the next update interval, 10:31:30, and transfers the first four byte burst. At 10:31:40, the TTE transfers the second burst to the GPI adapter. The second burst contains an hours byte, a minutes byte, a seconds byte and a Minus Zero byte. The Adapter Response, resulting from the Minus Zero byte, shall cause the EOM line to be raised by the TTE to terminate the mode.

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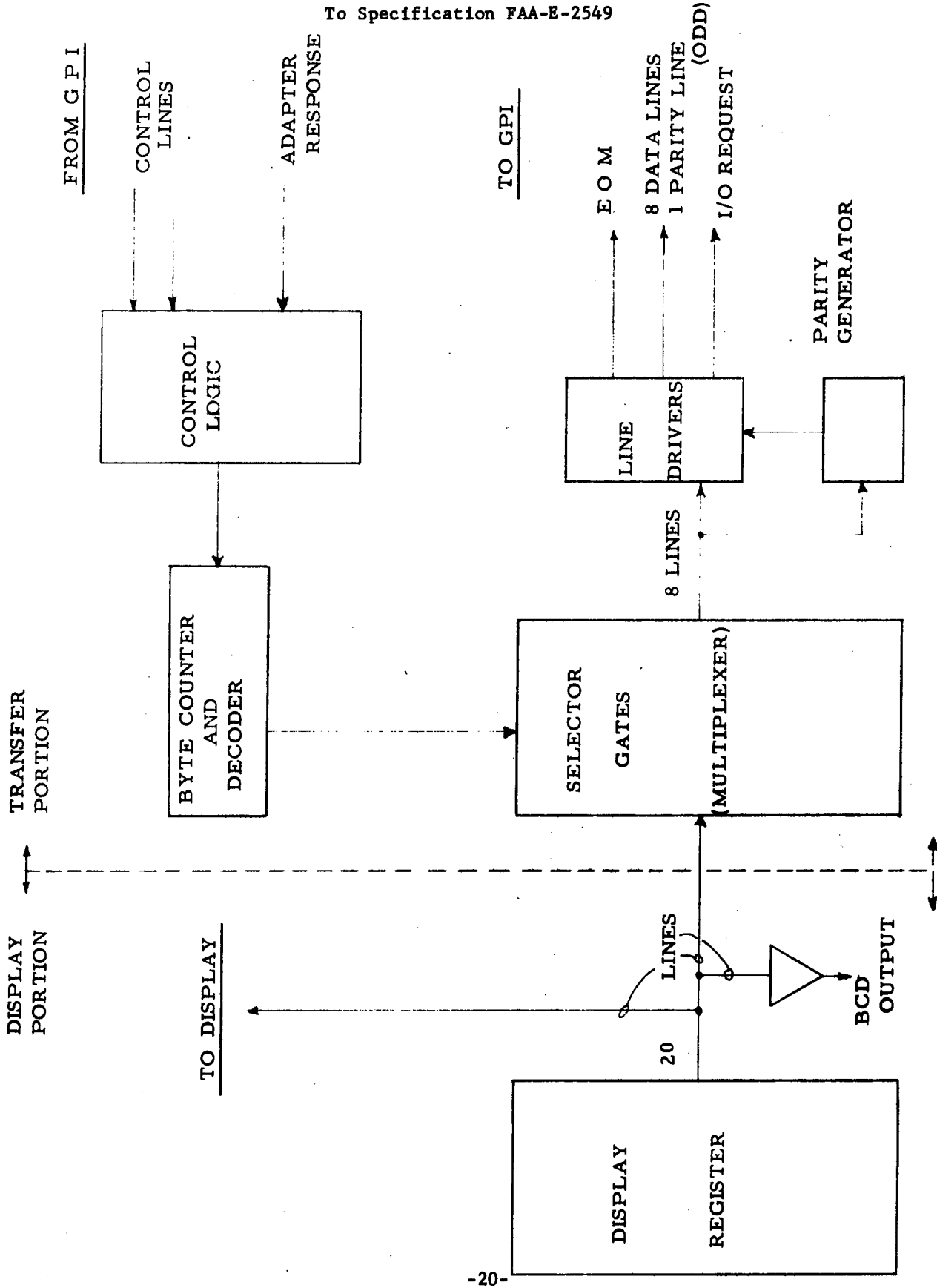
2

The Plus Zero and the Minus Zero bytes shall consist of fixed bit patterns gated or multiplexed onto the data lines at the appropriate time. The data lines shall present all zeros to the GPI adapter whenever the time-of-day data is not being transferred.

Output connection/pin assignment information will be provided ten (10) days after contract award. Output impedance will be 100 ohms as noted on figure 2.

APPENDIX B

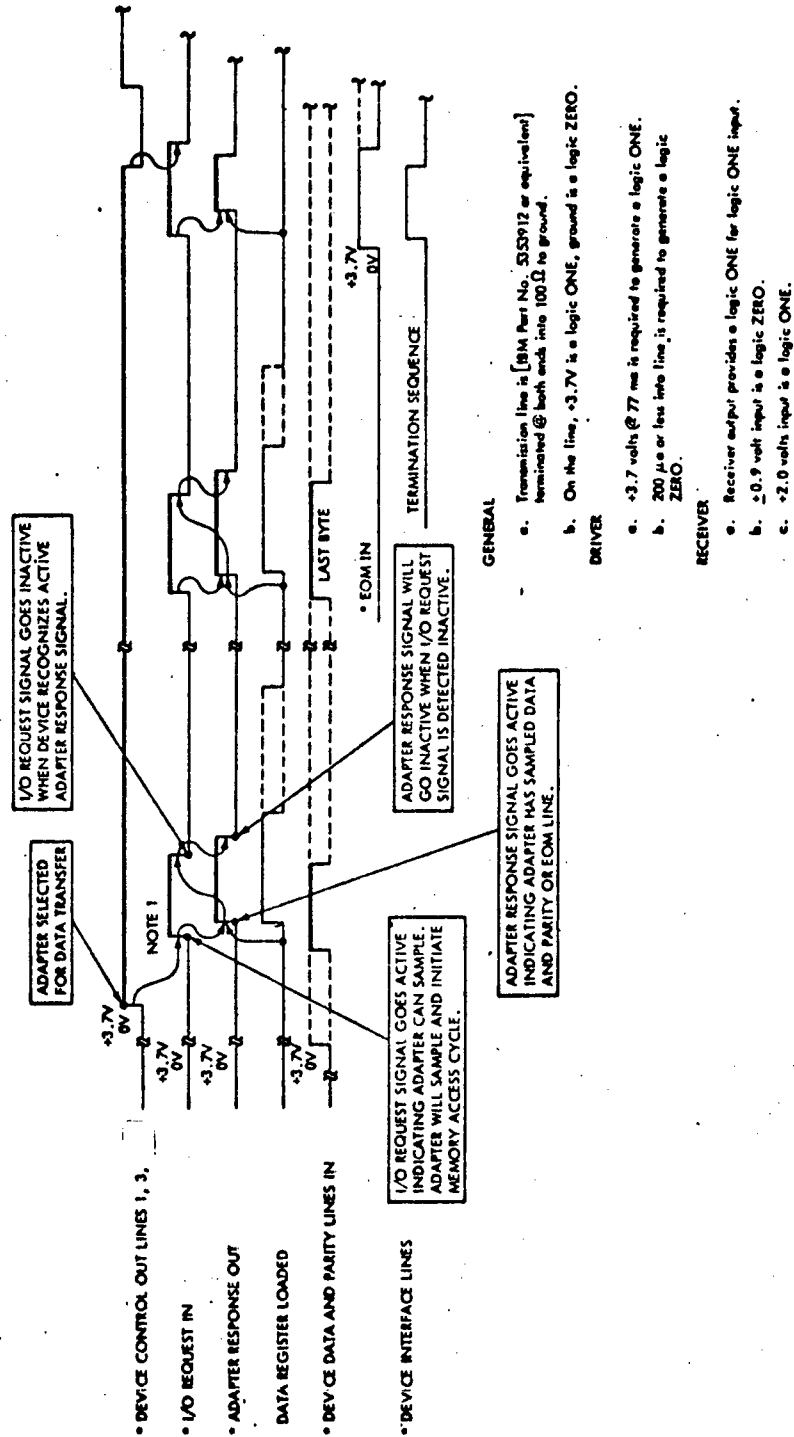
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TIME TRANSFER CIRCUITRY BLOCK DIAGRAM FIGURE #1

APPENDIX B

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General Purpose Input Adapter Interface Timing Chart

FIGURE 2

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CCC COMMAND CODES	DEVICE CONTROL LINE		
	1	3	4
RESET	0	0	0
UPDATE TIME	1	0	0
IMMEDIATE TIME	0	1	0

CCC COMMAND CODES

BYTE	BIT								
	0	1	2	3	4	5	6	7	
#1 HOURS	0	ERROR	H20	H10	H8	H4	H2	H1	
#2 MINUTES	0	M40	M20	M10	M8	M4	M2	M1	
#3 SECONDS	0	S40	S20	S10	S8	S4	S2	S1	
#4 ZERO PLUS	0	0	0	0	1	1	0	0	
#4 ZERO MINUS	0	0	0	0	1	1	0	1	
#5 EOM	0	0	0	0	0	0	0	0	

MESSAGE FORMAT

FIGURE 3